SEVERE WINTERS IN SOUTHERN GERMANY AND SWITZERLAND SINCE THE YEAR 1400 DETERMINED FROM SEVERE LAKE FREEZES[1]

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[Translated by W. W. Reed, Weather Bureau, Washington]

Hellmann's well-known investigations of the behavior of certain seasons over long periods (severe and mild winters, warm and cool summers, etc.) will always be of great importance as meteorological histories of large and small areas, respectively; one of the last of these valuable works treats of severe winters at Berlin during the period from 1766 to 1917. It presents a series of significant results, which have been summarized in clearly arranged manner in the work, "*Über strenge Winter*" (*Sitzungberichte der Preussischen Akademie der Wissenschaften, Dezember 1917, Nr. LII*). As a criterion in determining severe winters, Hellmann employs the sums of the negative daily temperature means for the months from November to March.

At about the same time that Hellmann's work appeared, I sought to classify the severe winters for the rather limited region of southern Germany and Switzerland, extending the investigation as far as possible into the past. Reliable temperature records for the earlier centuries are, of course, not available; however, I could well take very unusual lake and river freezing as a criterion of winter severity. The extremely severe winters, when for months at a time everything was frozen solid and for weeks all of the large lakes north of the Alpine divide were frozen over so thick that heavy wagons could cross, are well remembered. We have a series of reliable weather records, made by well-qualified writers [2] dating far back into the fifteenth century. By critical examination of these we can determine the severe winters as indicated by unusual freezing of the lakes in southern Germany and Switzerland. In thus classifying the severe winters we avoid the known inaccuracies in old temperature records (due to instrumental error, method of exposure, etc.) which affect comparisons and often prove troublesome.

From the long duration of lake freezing in the severe winters of 1829–30, 1879–80, and 1890–91 we know very reliably that there must be a negative temperature total (November, December, and January) of at least 350° to 400° C. for the lakes to be entirely frozen over for weeks.[3] In the severest winters at Berlin from 1766 to 1917 the sums of the negative daily temperature means from November to March ranged from 683° to 321° C. In the data for northern Germany there appears very plainly a great climatic oscillation. In the period from 1788 to 1845 there was an unusually large number of severe winters, among these some of the most severe on record, while since that period the number of such winters has shown a marked decrease. In the 58 years from 1788 to 1845 Hellmann counts 17 very severe winters and in the 71 years from 1846 to 1917 only 6. In the past 60 years there has been a marked relative increase in the number of mild winters in northern Germany and also in southern Germany and Switzerland.

For the same period (from 1788 to 1845) the number of severe winters in southern Germany and Switzerland is found to be quite different—only 3 (1788–89, 1799, and 1829–30). From this it is seen how totally different conditions may be even in the limited region including Germany and Switzerland. The 89-year period of recurrence of cold winters in middle (and western) Europe found by Easton has, therefore, no claim to general validity; it does not take into consideration the conditions just mentioned.[4]

If we make a critical study of the reports on severe lake and river freezes, we find the following series of severe winters in south-central Europe since the year 1400:

Severe winters in south-central Europe

1400–1500	1500–1600	1600–1700	1700–1800	1800–1900
1407–8	1513–14	1599–1600	1708–9	1829–30
1434–35	1516–17	1608–9	1717–18	1879–80
1443–44	1550–51	1659–60	1737–40	1890–91
1460–61	1562–63	1683–84	1754–55	1894–95
1464–65	1564–65	1684–85	1762–63	----------
1468–69	1570–71	1694–95	1788–89	----------
1476–77	1572–73	----------	----------	----------
1490–91	1586–87	----------	----------	----------

Another grouping may be given as follows:

1435–1587	15 severe winters in 153 years.
1588–1680	4 severe winters in 92 years.
1681–1800	10 severe winters in 120 years.
1801–1923	4 severe winters in 123 years.

From 1770 to 1923, in a period of 154 years, we count only 6 severe winters in South Germany and Switzerland, while from 1788 to 1845, in a period of only 58 years, Hellmann notes 17 such winters in northern Germany.

The exceedingly small number of severe winters (4) in south-central Europe from 1800 to 1923 certainly permits the conclusion that an offsetting will follow in the coming century; of course it is difficult to predict in what year this will begin.

An interesting circumstance is to be mentioned here Since the past summer there has been extremely little activity on the surface of the sun. Evidently the sun-spot minimum is rapidly approaching; indeed, according to the data recorded by Professor Wolfer at Zurich, it has already arrived. From all investigation we have these facts: Well-defined epochs of least solar activity since 1610 are known from Wolfer's table, the last sun-spot minimum occurring in 1913. Since the year 1600 the surface of the sun has been seen in its state of minimum activity 28 times. During the appearance of these sun-spot minima for more than 300 years it has happened only once (in 1754–55) that a severe winter in south-central Europe coincided with the epoch of sun-spot minimum. A long, servere winter at this time (1923–24) would therefore certainly be an anomaly in our latitude.

The large number of mild winters and the small number of very cold winters in south-central Europe since 1800 indicates a kind of "climatic oscillation," whose cause lies completely hidden.

[1] Translated from *Meteorologische Zeitschrift, Band XLI, Heft 3* (March, 1924), by W. W. Reed, Washington, D. C., May 19, 1924.

[2] The third volume of "*Der Sammler in den Alpen*," by J. M. Schirmer, is a valuable, though not well-known, source of weather records. This manuscript contains a rich collection of interesting Swiss weather reports covering the period from 1600 to 1800.

[3] In the severe winter of 1879–80 the sum of the negative daily temperature means at Zurich was 400° C. for the period from Nov. 1 (?) to Jan. 22, when the lake was frozen over entirely; the number of *Frosttage*, days with mean temperature below 0 C., was 79 from Nov. 1 to Feb. 10. For the same winter Arnet gave the total of negative temperature means at Lucerne from November to the end of February as only 430° C. and the number of *Frosttage* as 76. In the long winter of 1890–91 the negative temperature total at Zurich was 365° C., with 56 *Frosttage* from November to Jan. 21, the date of freezing. The total of negative temperatures at Zurich from November to the end of February was 458° C., while at Lucerne that from Nov. 26 to Feb. 22 was 426° C. on 84 *Frosttage*. The thickness of the ice on the lower part of Lake Zurich was 6 cm. on Jan. 22 and 14 cm. on Jan. 30, 1891, while the river ice at the outlet had a thickness of 40 cm.

[4] W. Köppen, "*Eine 89 jahrige Periode in der Witterung*," *Meteorologische Zeitschrift, 1918, S. 98.*